Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Unlicensed Use of the 6 GHz Band	)	ET Docket No. 18-295
	)	
Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz	)	GN Docket No. 17-183
	)	

To: The Commission

COMMENTS OF

OPEN TECHNOLOGY INSTITUTE AT NEW AMERICA
AMERICAN LIBRARY ASSOCIATION
CONSUMER FEDERATION OF AMERICA
COSN—CONSORTIUM FOR SCHOOL NETWORKING
PUBLIC KNOWLEDGE
ACCESS HUMBOLDT

February 15, 2019

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The above-listed nonprofits, together the Public Interest Organizations ("PIOs"), hereby submit initial Comments in response to the Notice of Proposed Rulemaking in the above-captioned proceedings ("*NPRM*").[1] The PIOs generally support the Commission's proposal to authorize unlicensed sharing across the entire 1,200 megahertz from 4925 to 7125 MHz.

As organizations committed to facilitating more open, fast and affordable wireless connectivity for all Americans, the PIOs strongly agree that affordable access to the 6 GHz band in every home and business is essential for gigabit-fast Wi-Fi and other connectivity needs as the nation advances to a 5G wireless ecosystem. Access to 6 GHz spectrum proximate to the 5 GHz band is also needed for high-capacity fixed wireless in rural and underserved communities. To achieve these goals, the PIOs propose changes aimed at ensuring that the 6 GHz band brings the benefits of unlicensed spectrum to homes, schools, small businesses and others that need it most.

[1] *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Proposed Rulemaking, ET Docket No. 18-295 and GN Docket No. 17-183, FCC 18-147 (rel. Oct. 24, 2018). The *NPRM* was published in the Federal Register on December 17, 2018. *See* 83 Fed. Reg. 64506 (Dec. 17, 2018).

I. Summary and Introduction

Unlicensed spectrum is what ultimately makes both mobile and fixed broadband service more ubiquitous, productive and affordable for an overwhelming majority of Americans at home, at work, at school, and in public places. Most wireless devices rely entirely on unlicensed spectrum for connectivity. Wi-Fi generates hundreds of billions of dollars in economic activity and consumer surplus each year, in substantial part as a critical complement to mobile carrier networks that would otherwise be overwhelmed by consumer demand. Wi-Fi also plays an increasingly important role in connecting education, manufacturing, agriculture, and healthcare technologies. While Wi-Fi has been a critical pillar of the nation's 4G wireless ecosystem, IoT and other high-capacity networks – most of which will be indoors and connect everything – are likely to make unlicensed spectrum an even more critical part of a truly robust 5G ecosystem.

The Public Interest Organizations (PIOs) strongly support the Commission's proposal to allow low power, indoor-only operations on an unlicensed basis in the U-NII-6 and U-NII-8 bands. OTI urges the Commission to likewise authorize low power, indoor-only unlicensed use across the U-NII-5 and U-NII-7 band segments without the cost and complexity of AFC coordination. The overwhelming majority of consumer welfare and economic value generated by unlicensed spectrum – and particularly by Wi-Fi – is indoors, in homes and businesses literally walled off from incumbent receivers in the U-NII-5 and U-NII-7 band segments. Although expensive, professionally-installed, higher-power and AFC-controlled unlicensed access is important for enterprise and outdoor deployments, the failure to set a power level at which Wi-Fi can operate indoors across the entire 6 GHz band, using off-the-shelf routers and low-cost devices, will sacrifice what is likely to be the greatest benefit of this rulemaking. without affordable, do-it-yourself access to the 850 megahertz in U-NII-5 and U-NII-7, a majority of

homes and small businesses in particular will likely be limited *to a single 160 megahertz channel* between 6.875 and 7.125 GHz (U-NII-8 segment).

There are at least three reasons the PIOs believe the Commission can adopt a rebuttable presumption that low-power, indoor-only unlicensed access to the U-NII-5 and U-NII-7 band segments does not create an undue risk of harmful interference to incumbents:

First, harmful interference from low power, indoor-only RLANs into FS receivers would be extremely rare even without frequency coordination by an AFC. The two operate in entirely different locations and with transmit characteristics that are complementary.

Second, the record demonstrates that FS links are high power and use high-quality, highly-directional antenna, whereas indoor home Wi-Fi and other unlicensed devices operate at very low duty cycles with low EIRP.

Third, moving Wi-Fi and other unlicensed traffic onto networks required to be low power and indoors could reduce the overall risk of interference to FS incumbents. The less obvious reason is that by making 1,200 contiguous megahertz available inside every building, unlicensed routers and other devices will spread their transmissions over multiple and much wider channels.

The PIOs urge the Commission to adopt rules for outdoor, AFC-controlled fixed wireless deployments that are harmonized with Part 15 rules allowing higher gain antennas in the 5 GHz bands currently in use for rural broadband, enabling higher EIRP operations that cover larger areas more affordably. Equipment already widely deployed in the 5 GHz band is easily adaptable to operate in the 6 GHz band. Further, although rural broadband deployment would be a primary beneficiary of a rule permitting higher-power operations, the Commission should not impose any limitation that would prevent higher-power operations from being used wherever the AFC authorizes interference-free access. We also suggest the Commission open more contiguous

bandwidth for fixed wireless providers by authorizing AFC-controlled use of those portions of the U-NII-8 segment that are not currently populated by BAS operations.

The PIOs concur that in this band Automated Frequency Control (AFC) systems can be relatively simple databases that are easy to implement. AFC is well-established and reliable in bands, such as U-NII-5 and U-NII-7, where incumbent operations are geographically fixed, technically well-characterized, and change location or operating parameters infrequently. We recommend that the Commission adopt a flexible approach that allows both centralized and decentralized models for device and end-user coordination. The Commission should also give all certified AFC systems the flexibility to incorporate real-world GIS data (e.g., terrain, clutter, building heights) and a range of advanced propagation models that facilitate both a more intensive use of the band and a more precise protection of incumbent operations. Variation among AFC operators is positive for innovation and to encourage a diversity of use cases and service tiers. Cost recovery for AFC operators should be a given; but the Commission should also strive to minimize transaction costs, or arrangements that exclude or deter ordinary consumers.

Finally, our view on device registration hinges on whether the Commission authorizes low power and indoor-only unlicensed use across the U-NII-5 and U-NII-7 band segments without the added cost and complexity of AFC coordination. If unlicensed use of the 850 megahertz in those two band segments inside homes, retailers, schools, libraries and offices is subject to ongoing AFC control, ordinary consumers and small business owners will be swept up in a cumbersome registration process and the payment of fees. Even worse would be a requirement of professional installation. Under the scenario proposed in the *NPRM*, our groups would strongly oppose any device registration requirement.

II. Exploding Demand Requires Large and Contiguous New Allocations of Unlicensed Mid-Band Spectrum

Unlicensed spectrum is what ultimately makes both mobile and fixed broadband service more ubiquitous, productive and affordable for an overwhelming majority of Americans at home, at work, at school, and in public venues. A rapidly expanding majority of wireless devices rely entirely on unlicensed spectrum for connectivity. Consumers, businesses, schools and libraries increasingly rely on unlicensed spectrum each year in a myriad of ways that make it not only vital to the economy, but to modern lifestyles as well. Wi-Fi generates hundreds of billions of dollars in economic activity and consumer surplus each year, in substantial part as a critical complement to mobile carrier networks that would otherwise be overwhelmed by consumer demand. Wi-Fi offloads 70 to 80 percent of all mobile device data traffic and serves as the common interface between increasingly convergent fixed and mobile networks. While Wi-Fi has been a critical pillar of the nation's 4G wireless ecosystem, emerging IoT and other high-capacity networks – most of which will be indoors and connect everything – are likely to make unlicensed spectrum an even more critical component of a truly robust 5G ecosystem.

Unlicensed technologies serve as the backbone for functions that help to make schools, libraries, warehouses, farms, and hospitals run more efficiently, which is particularly important to small entities that need more cost-effective connectivity to compete and improve quality. The burgeoning Internet of Things (IoT), virtual reality, interactive high-definition video, and other recent innovations suggests that open and flexible access to large, contiguous bands of unlicensed spectrum will become even more important in a 5G wireless ecosystem. The need for very wide, contiguous channels to enable gigabit Wi-Fi is pressing, particularly for indoor use where a high number of users can create latency issues.

A. Consumer Demand and the Economic Value of Unlicensed Spectrum Continues to Grow Rapidly

In the *NPRM*, the Commission acknowledges the crucial role that unlicensed spectrum plays in our technology-driven, 21st century economy: Wi-Fi "has become indispensable for providing high data rate local area network connections for smart phones, tablets, mobile computers, and other devices to interconnect and access the Internet. Wi-Fi has also enabled the offloading of data from commercial wireless networks . . . and it has provided a means for devices throughout the home to wirelessly interconnect."[2]

The open, off-the-shelf nature of unlicensed technologies make high-capacity internet access more affordable for all Americans and represent a rapidly growing component of the economic value of wireless communications. According to a recent report, in the U.S. the current economic surplus attributable to unlicensed spectrum from a selected set of applications adds up to $496 billion today *at least*, and also provides $29 billion to the country's GDP.[3] The same report, by Dr. Raul Katz, Director of Business Strategy Research at Columbia University's Center for TeleInformation, highlighted the importance of Wi-Fi for offloading mobile data. The report found that Wi-Fi cellular offloading brought the U.S. economy $25.2 billion in 2017.[4] Mobile carriers rely on fixed networks and Wi-Fi in particular for the vast majority of the

[2] *NPRM* at ¶ 4.

[3] "Economic Value of Unlicensed Spectrum in the U.S. Tops $525 Billion," Wi-Fi Forward, (May 17, 2018), http://wififorward.org/2018/05/17/new-report-economic-value-of-unlicensedspectrum-in-the-u-s-tops-525-billion/.

[4] *Ibid.*

bandwidth consumed by mobile devices, and this is particularly true for devices used while indoors, where more than 80% of mobile data is consumed.[5]

Unlicensed spectrum also provides the primary source of connectivity for machine-to-machine data transfer and emerging industrial IoT networks—including for energy and environmental monitoring and controls, mobile healthcare monitoring, industrial automation, intelligent transportation networks, smart meter reading, control systems for agricultural technology, vehicle tolling, inventory tracking, and traffic lights. All of these are among the use cases experiencing dramatic growth with declining costs to consumers thanks to open, unmediated connectivity using unlicensed bands.[6] As the U.S. mobile industry begins to deploy 5G and consumers start to adopt the new technology, the need for Wi-Fi and other unlicensed technologies will grow.[7]

The importance of unlicensed technologies, and Wi-Fi in particular, to the U.S. economy is immense. However, Wi-Fi is employed for a wide variety of education and enterprise uses that require strong connectivity across an entire floor or in every room. Therefore, the authorization of at least low power, indoor-only use across the entire 5.925-7.125 GHz band is crucial.

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[5] Comments of the Open Technology Institute at New America, American Library Association, the Benton Foundation, Consumer Federation of America, Consumers Union, Institute for Local Self-Reliance, National Hispanic Media Coalition, Next Century Cities, Public Knowledge, Schools, Health, & Libraries Coalition, and X-Lab, GN Docket No. 17-258, GN Docket No. 15-319, GN Docket No. 17-183, GN Docket No. 14-177 (Sep. 11, 2018), https://ecfsapi.fcc.gov/file/1091216959118/PISC_Comments_SpectrumPipelineAct_FINAL_AsFiled_091118.pdf at 22-23 ("The mobile device data traffic transported over Wi-Fi networks - rather than over mobile carrier networks -- is increasing and vastly exceeds all other wireless technologies, making more spectrum capacity for Wi-Fi critical…").

[6] *See* Richard Thanki, *The Economic Significance of License-Exempt Spectrum to the Future of the Internet*, at 65 (June 2012).

[7] David Nield, "Why You'll Still Need Wifi When 5G Is Everywhere, According to the Wi-Fi Alliance" (Dec. 18, 2018), https://gizmodo.com/why-youll-still-need-wifi-when-5g-is-everywhere-accord-1831167997.

1. Farming and Ranching

Wi-Fi networks could play a more central role in agriculture as M2M and IoT mature. Smart agriculture is already used widely across the United States. For smart farming tools, Wi-Fi networks are preferable to LTE and 4G networks because, once built, they are more economically feasible to sustain, customize and operate.[8] Farmers have the capability to check data and weather conditions on their mobile devices, and Wi-Fi is particularly well-suited for smaller farms.[9]

Tests have already shown how effective Wi-Fi can be in rural areas. The company BlueTown set up a Wi-Fi network at the University of California's Kearney Agricultural Research and Education Center (KARE) that provided 250 Mbps throughput.[10] BlueTown uses a low-power solution, and uses poles with omnidirectional antennas that have a 250-meter radius of Wi-Fi signal.[11] This solution has distinct benefits for farming. In the demonstration at KARE, there are sensors placed throughout an alfalfa field, and the sensors detect and review sub-surface irrigation in comparison to flood irrigation.[12] "One of the nice things about the W-Fi is

[8] Stephanie Bergeron Kinch, "Agriculture: A cash cow for Wi-Fi-based IoT?," Wi-Fi NOW (June 2, 2018), https://wifinowevents.com/news-and-blog/agriculture-a-cash-cow-for-wi-fi-based-iot/, (Agnov8's CEO Andrew Cameron "says that Wi-Fi has a competitive advantage over LTE and 4G networks because it is more economically feasible to maintain and operate once it is installed. Farmers can check data and conditions on their smartphones and tablets, and the system is compatible with other Wi-Fi-enabled technology. Wi-Fi works especially well for smaller farms, he says.").

[9] *Ibid.*

[10] Susan Rambo, "High-speed Wi-Fi at ag research center may be blueprint for rural communities," RCR Wireless (July 20, 2018), https://www.rcrwireless.com/20180719/internet-of-things/high-speed-wifi-at-ag-research-center-may-be-blueprint-for-rural-communities-tag41.

[11] *Ibid.*

[12] *Ibid.*

we can move to real-time evaluation of the data that is coming off this field," Dr. Jeffery A. Dahlberg, director of KARE, told RCR Wireless.[13]

These Wi-Fi networks enable the delivery of real-time information for farmers, as agriculture equipment manufacturers expect IoT connectivity to play a crucial role in the future of the industry. Deere & Company has testified to this point in the past: "As these machine populations continue to grow . . . our reliance on rural broadband coverage will only increase, and the ability of farmers using Deere's agricultural equipment and systems to improve efficiency, yield, and smart resource use will depend on their ability to leverage high speed broadband connections capable of enabling real-time M2M and machine to farm (M2F) interaction. The Internet of Things in rural America will include not only smart meters and smart appliances, but also smart farming equipment and systems needed to drive local economies."[14] Precision farming, which allows for more cost-effective agriculture, is particularly important to small farms struggling for higher yields and labor efficiencies.

2. Manufacturing

Another enormously valuable and increasingly widespread use of unlicensed spectrum indoors is in the manufacturing industry. Entire warehouses and production lines are outfitted with Wi-Fi networks that control and tie together robots, sensors, inventory tracking and other efficiency gains. Amazon uses unlicensed spectrum to control the robots in their warehouses (more than 100,000 robots as of 2017), using a customized indoor network reportedly based on a

[13] *Ibid.*

[14] Comments of Deere & Company, GN Docket No. 17-199 (Sep. 21, 2017), https://ecfsapi.fcc.gov/file/109212496527376/FINAL_Deere%20Comments%20on%20Section%20706%20NOI.pdf (Deere & Company Comments).

variations of the Wi-Fi 802.11 standard.[15] Amazon controls the robots through a centralized computer using a secured Wi-Fi network.[16] The robots increase efficiency exponentially. Before the robot networks were deployed, warehouse workers would have to search the shelves for a specific item and haul it to the packing and shipping area before sending it out.[17] Today, as the robots dart around Amazon's enormous fulfillment centers, employees walking the floors are protected by badges transmitting their location via Bluetooth.

The use of unlicensed spectrum and Wi-Fi to automate manufacturing and increase efficiency is spreading to other industries and smaller companies as well. A robotics startup, called 6 River Systems (6RS), builds robots similar to Amazons that work with humans to guide them to shelves to find a specific item, find the item on that shelf, let them know how much of a certain product is needed, and help carry up to 160 pounds.[18] The robots also ensure the fastest, most efficient routes are taken as these tasks are fulfilled. The secret to the robots, as at Amazon, is Wi-Fi.[19] "All they need is Wi-Fi in the warehouse," Jerome Dubois, 6RS cofounder and co-CEO, told Forbes. "It makes it easier to implement because there's no tearing out stuff or retrofitting the facility."[20]

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[15] Nick Wingfield, "As Amazon Pushes Forward With Robots, Workers Find New Roles," New York Times (Sep. 10, 2017), https://www.nytimes.com/2017/09/10/technology/amazon-robots-workers.html.
[16] Pablo Valerio, "Amazon Robotics: IoT in the Warehouse," *Information Week* (Sep. 28, 2015), https://www.informationweek.com/strategic-cio/amazon-robotics-iot-in-the-warehouse/d/d-id/1322366.

[17] Will Knight, "Inside Amazon's Warehouse, Human-Robot Symbiosis," *MIT Technology Review* (July 7, 2015), https://www.technologyreview.com/s/538601/inside-amazons-warehouse-human-robot-symbiosis/.

[18] Alex Knapp, "This Robot Startup Just Raised $25 Million to Make Warehouse Fulfillment Easier," *Forbes* (April 4, 2018), https://www.forbes.com/sites/alexknapp/2018/04/04/this-robot-startup-just-raised-25-million-to-make-warehouse-fulfillment-easier/#18d3693d6ffe.

[19] *Ibid.*

[20] *Ibid.*

3. Hospitals

Hospitals stand to benefit disproportionately from the high-capacity next generation Wi-Fi technologies (Wi-Fi 6) provided there is enough contiguous, wide-channel spectrum available. As Wi-Fi Alliance notes: "Hospitals are a perfect example of congested, high traffic, constantly changing environments that would benefit from Wi-Fi 6. Wi-Fi is common in hospitals given the many benefits it provides."[21] Some uses of Wi-Fi in hospitals include remote monitoring of patients and devices from nurses at their main station, interconnected devices used to communicate accurate patient records and real-time data analysis, and the sending and reception of real-time alerts and observation data.[22]

Because of all the interconnected devices in any given hospital, the medical industry alone has tens of thousands of locations where high-capacity unlicensed networks are not just preferred, but absolutely necessary. As more smart devices are adopted at hospitals and the use of data analysis in healthcare grows, the need for large, contiguous bands of unlicensed spectrum for indoor use is absolutely vital.

4. Schools and Education/E-Rate

Wi-Fi plays a critical role in education as well. Students use Wi-Fi in schools for individualized lesson plans, as well as in libraries, schools, and restaurants to complete homework. The success of the Commission's E-Rate program, and specifically the high participation rate of schools and libraries in the program's "category two" funding for internal connections (generally Wi-Fi), is an example of how indoor use of unlicensed spectrum can have

[21] Jay White, "Wi-Fi 6 and healthcare," Wi-Fi Alliance (Jan. 15, 2019), https://www.wi-fi.org/beacon/jay-white/wi-fi-6-and-healthcare.

[22] *Ibid.*

a profound impact. Since the Commission modernized E-Rate, and the program's funding mechanism over category two funding (eliminating the "Two-in-Five Rule"), participation in the program has increased at extremely high rates. According to the Wireline Competition Bureau's latest report on E-Rate's category two budget, the average number of schools receiving category two funding (or pending requests) is at about 45,000 per year, which marks a 525% increase from the time period of Fiscal Year 2008 and Fiscal Year 2012.[23] Libraries experienced a similar boom in participation—about 2,700 libraries per year receive category two commitments or pending requests, which marked an 865% increase.[24] Most libraries are small and thinly funded, making access to low-cost, off-the-shelf networking solutions imperative.

This accelerating demand for connectivity and capacity is having concrete effects on school Wi-Fi networks. Since the Commission modernized the E-Rate program, 83% of schools districts have invested in Wi-Fi upgrades, which marked an immense increase from 14% in 2011-2014.[25] School districts are investing in Wi-Fi at much higher rates as well, with $2.9 billion going to building Wi-Fi networks from 2015 to 2018, compared to $1.5 billion between 2011 and 2014.[26]

This data, which reflects widespread development and maintenance of internal networks, shows the utility K-12 schools see in Wi-Fi for learning. This importance was underscored by nearly 200 school and district leaders and over 50 education organizations in a filing with the Commission: "Category two services that support high-speed internet access, including reliable

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[23] Wireline Competition Bureau Report, WC Docket No. 13-184, at ⁋⁋ 17-18 (Feb. 11, 2019), https://docs.fcc.gov/public/attachments/DA-19-71A1.pdf.

[24] *Ibid.*

[25] EducationSuperHighway, "2018 State of the States" (Oct. 2018), https://s3-us-west-1.amazonaws.com/esh-sots-pdfs/2018%20State%20of%20the%20States.pdf.

[26] *Ibid.*

Wi-Fi, are vital for providing all students with a quality education to prepare them for today's modern economy."[27] The American Library Association has long advocated for the E-Rate program and underscored the importance of Wi-Fi to libraries across the country.[28]

Indoor use of unlicensed spectrum is crucial to teachers' modern-day lesson plans. To actually distribute high-speed broadband connectivity across an entire school or library, these entities need robust Wi-Fi. According to a teacher survey of Alexandria City Public Schools in Virginia conducted by New America, 80% of teachers said that two of the most common student uses for internet-connected devices (Chromebooks, iPads, and desktop computers) are to provide a variety of instruction methods to daily lessons, and to curate learning experiences to every individual student.[29]

A significant number of teachers (75%) also said that internet-connected devices empower teachers to offer more self-directed learning and independent practice.[30] For teachers to actually be able to take advantage of these internet-connected devices and the novel teaching capabilities that come with them, schools need a strong Wi-Fi network. Schools also extend Wi-Fi networks for use in their lobbies, football fields, theaters, gymnasiums, and all over the school's grounds. As Zeus Kerravala, founder and principal analyst at ZK Research, told *EdTech*

[27] Reply Comments in the Form of a Letter From 191 School and District Leaders from 38 States Requesting that the Federal Communications Commission Support High-Speed Broadband and Wi-Fi through E-Rate Category Two Services, WC Docket No. 13-184 (Nov. 7, 2017), https://all4ed.org/wp-content/uploads/2017/11/school-and-district-leader-support-letter-for-e-rate.pdf.

[28] Comments of American Library Association, WC Docket No. 13-184 (Oct. 23, 2017), https://ecfsapi.fcc.gov/file/102330495230/ALA_E-rate_Comments_10_23_2017.pdf, ("High-speed internet connections and robust Wi-Fi are essential for all libraries and underpin services on which communities across the country depend.").

[29] Lindsey Tepe and Chris Ritzo, "Measuring Broadband in Alexandria City Schools," New America (June 6, 2017), https://www.newamerica.org/in-depth/measuring-broadband-alexandrias-schools/iii-teacher-survey-and-discussions/.

[30] *Ibid.*

Magazine: "The most important reason for it is being able to expand learning capabilities outside the traditional classroom."[31]

B. Both Current and Emerging Use Cases for High-Capacity Unlicensed Connectivity Require New Wide-Channel Allocations

The 20 megahertz channels and limited, fragmented capacity that characterize today's unlicensed bands simply do not offer enough capacity to accommodate projected increases in demand, including the demand for interactive, real-time applications such as VR and video calling. Wider channels up to 160 MHz will be critical to fuel very high-bandwidth applications and pervasive connectivity, including for emerging IoT networks, for high-capacity fixed wireless services in rural and low-density areas, and for other innovation. This is particularly true in the enterprise environment, and in user-dense venues such as schools, hotels, retail malls, factories, office complexes, sporting events and other venues where the aggregate demand for bandwidth and low-latency will outstrip current Wi-Fi capabilities.

The mobile device data traffic transported over Wi-Fi networks – rather than over mobile carrier networks – is increasing roughly 40% each year and vastly exceeds all other wireless technologies, making more spectrum capacity for Wi-Fi critical. Unlicensed spectrum currently available in the 2.4 GHz and 5 GHz unlicensed bands "carry more internet data than any other wireless technology or service, with usage expected to continue increasing at a rapid pace."[32]

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[31] Dan Tynan, "Schools Expand Wi-Fi Beyond the Classroom" (Jan. 11, 2018), https://edtechmagazine.com/k12/article/2018/01/schools-expand-wi-fi-beyond-classroom.

[32] Comments of All Points Broadband, Amplex Internet, Apple, Blaze Broadband, Broadcom, Cambium Networks, Cisco Systems, Cypress Semiconductor, Dell, Extreme Networks, Facebook, Fire2Wire, Google, Hewlett-Packard Enterprise, HP, Intel, Joink, MediaTek, Metalink Technologies, Microsoft, New Wave Net, Pixius Communications, Qualcomm, Rise Broadband, Ruckus, Snappy Internet, Sony Electronics, Western Broadband, Wireless Internet Service Provider Association, and Wisper ISP, GN Docket No. 17-183, at 5 (Oct. 2, 2017), citing the Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016– 2021, 21–22 & fig. 23 (2017),

Cisco's ongoing Visual Networking Index forecasts continued year-over-year growth of 30 percent in overall internet data traffic, with nearly 80 percent of all internet traffic flowing over mobile (22 percent) or Wi-Fi networks (57 percent) by 2022.[33] In 2017, mobile networks accounted for only 9 percent of total global IP traffic, compared to 43 percent for Wi-Fi, and 48 percent for wired networks.[34] Globally, Cisco projects there will be nearly 549 million public Wi-Fi hotspots by 2022, up from 124 million hotspots in 2017, a fourfold increase.[35]

Like electricity, wireless connectivity is a critical input to most other economic activity and is rapidly becoming even more pervasive. Unlicensed technologies already make up 70% of smart grid communications, 80% of wireless healthcare solutions, over 90% of wireless tablet connectivity, and almost all RFID inventory and asset tracking.[36] As a result, studies project daunting deficits in the availability of both licensed and unlicensed spectrum. A study commissioned by the Wi-Fi Alliance projects a shortfall of between 500 MHz and 1 GHz of unlicensed spectrum by 2025.[37] A separate study by Qualcomm reached a similar conclusion,

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https://www.cisco.com/c/en/us/solutions/collateral/serviceprovider/visual-networking-index-vni/mobilewhite-paper-c11-520862.pdf.

[33] Cisco, *Cisco Visual Networking Index: Forecast and Trends, 2017– 2022*, White Paper, at 23 & fig. 22 (updated Nov. 26, 2018) ("*Cisco VNI 2017-2022*"), available at https://bit.ly/2TYstY8. Mobile device traffic was expected to reach 6.9 GB per month per active smartphone in North America by the end of 2017. *See Ericsson Mobility Report* (June 2017), at 14, available at https://www.ericsson.com/assets/local/mobility-report/documents/2017/ericsson-mobility-reportjune-2017.pdf.

[34] *Cisco VNI 2017-2022*, *supra note* 33.

[35] *Id.* at 21. Cisco reports that Western Europe had the highest number of hotspots, with 48 percent of the world's Wi-Fi hotspots in 2017, but that Asia is likely to have the highest number (47 percent) by 2022. "Critical enablers of Hotspot 2.0 adoption are higher speed Wi-Fi gateways and the adoption of the IEEE 802.11ac and the latest 802.11ax standards." *Ibid*.

[36] Yochai Benkler, Open Wireless vs. Licensed Spectrum: Evidence from Market Adoption, 26 HARV. J. L. & TECH. 1 (Fall 2012), at p. 72; Reply Comments of The Open Technology Institute at New America and Public Knowledge, GN Docket No. 17-183, (Nov. 15, 2017), at 26.

[37] Steve Methley & William Webb, Quotient Assocs. Ltd., *Wi-Fi Spectrum Needs Study*, at 29 (Feb. 2017)

finding that "regulators should plan for around 1280 MHz of unlicensed spectrum centered around the 5 GHz band for use by unlicensed technologies."[38] Current commissioners have recognized this growing need for years.[39]

A key advantage of Wi-Fi is that many users can all use the same channel at the same time, but when a large number of users share a channel, it slows throughput and in turn disrupts high-bandwidth and latency-sensitive applications like video calls.[40] Multiple wider channels are necessary to help alleviate this problem – and allow open, unlicensed connectivity to keep pace as a complement to mobile carrier 5G networks. The 6 GHz band presents a particularly important chance to offer wider channels for unlicensed spectrum due to the shortage of contiguous unlicensed spectrum to support the current IEEE 802.11ac and pending 802.11ax Wi-Fi standards that have the potential to bring gigabit connectivity and lower latency in a very cost-effective manner.

("[B]etween 500 MHz and 1 GHz of new spectrum will be needed in 2025 to satisfy the anticipated busy hour."), available at https://bit.ly/2NSC7YL.

[38] Rolf de Vegt et al., Qualcomm Techs., Inc., *A Quantification of 5 GHz Unlicensed Band Spectrum Needs* 5 (2017).

[39] *See, e.g.*, Commissioner Michael O'Rielly, "A Mid-Band Spectrum Win in the Making," FCC Blog (July 10, 2017, 2:30 PM), available at https://bit.ly/2BEMDPt ("Study after study has shown that the U.S. is going to need multiple gigahertz of licensed and unlicensed spectrum just to keep up with current growth patterns"); Commissioner Jessica Rosenworcel, "Bringing the Connected Future to All Americans," FCC Blog (Dec. 30, 2016), https://bit.ly/2EcSZHs ("[A]s any wireless user can attest to, the airwaves used for Wi-Fi today are getting crowded—putting a premium on identifying additional spectrum for unlicensed growth.").

[40] Michael Calabrese, "Spectrum Silos to Gigabit Wi-Fi," New America Report, at 8 (January 2016), https://bit.ly/2IhWe4t.

III. The Commission Should Authorize Indoor, Low Power Use Across All Four Band Segments Without Burdening Consumers with Coordination Requirements

The PIOs strongly supports the Commission's proposal to allow low power, indoor-only operations on an unlicensed basis in the U-NII-6 and U-NII-8 bands.[41] The PIOs also urge the Commission to authorize low power, indoor-only unlicensed use across the U-NII-5 and U-NII-7 band segments without the cost and complexity of AFC coordination. The overwhelming majority of consumer welfare and economic value generated by unlicensed spectrum – and particularly by Wi-Fi – is indoors, in homes and businesses literally walled off from incumbent receivers in the U-NII-5 and U-NII-7 band segments. Although expensive, professionally-installed, higher-power and AFC-controlled unlicensed access is important for outdoor deployments, the failure to set a power level at which Wi-Fi can operate indoors across the entire 6 GHz band will sacrifice what is likely to be the greatest benefit of this rulemaking.

As the Commission states in the *NPRM*, "76 percent of North America broadband households use Wi-Fi routers as their primary connected technology."[42] But, of course, it's not just home routers that are soaking up bandwidth. Wi-Fi is the workhorse of the Internet because low-cost, off-the-shelf routers can easily and affordably offer access to unlicensed spectrum that provides high-capacity connectivity in the workplace, at school, in libraries, at restaurants, retailers and virtually every public place. The vast majority of these locations are do-it-yourself installations, not professionally-installed and expensive enterprise networks. If the Commission denies consumers and small businesses low power, indoor and affordable access to the largest

[41] *See Id.* at ¶ 59 and ¶ 73.

[42] *Id.*

and most productive portions of the 6 GHz band – that is, to the 850 MHz necessary to actually address the in-building Wi-Fi bottleneck – it will make this proceeding at best a partial success.

Even if incumbents can demonstrate worst case scenarios that result in some interference to some small number of incumbents, the Commission should weigh this against the enormous opportunity loss to consumers and all other businesses. As we described in the section above, the public interest in this proceeding rests in large part on the shortage of unlicensed spectrum for local networks *inside virtually every home, business, school, and public building*. But without affordable, do-it-yourself access to the 850 megahertz in U-NII-5 and U-NII-7, a majority of homes and small businesses in particular will likely be limited *to a single 160 megahertz channel* between 6.875 and 7.125 GHz (U-NII-8 segment). This falls far short of what Wi-Fi and other RLAN technologies will need indoors to ensure a truly robust 5G wireless ecosystem. The home and business broadband bottleneck is rapidly reversing: Instead of the fixed connection being the limiting factor in the throughput experienced by RLAN devices, cable and fiber networks will soon provision gigabits of capacity to every home and business. Because of the lack of wide, contiguous channels, Wi-Fi routers don't have enough capacity to distribute to devices (and soon proliferating IoT networks) the gigabits of connectivity that fixed ISPs are increasingly able to deliver.

There are at least three reasons that the PIOs believe the Commission can adopt a rebuttable presumption that low-power, indoor-only unlicensed access to the U-NII-5 and U-NII-7 band segments does not create an undue risk of harmful interference to incumbents:

First, harmful interference from low power, indoor-only RLANs into FS receivers would be extremely rare even without frequency coordination by an AFC. The two operate in entirely different locations and with transmit characteristics that are complementary. One is indoor-only,

and the other is outdoor-only. FS fixed links are very high-power and directional, while indoor RLANs are very low power. FS fixed links are tower- or rooftop-mounted, while unlicensed devices typically operate at or near ground level. FS links transmit continuously at high power, while RLAN devices operate at very low duty cycles with low EIRP.

Unlike outdoor or enterprise Wi-Fi deployments, low-power indoor-only Wi-Fi routers would operate entirely within a home or business, where building materials significantly attenuate the already low-power signal and minimize any potential interference.[43] The technical study submitted by the 6 GHz high-tech coalition, which the Commission cited in the *NPRM*, projects that 98% of RLAN deployments will be indoors by 2021 and only 2% outdoors.[44] Routers are almost always on the floor, or mounted high in a corner; rarely would they be positioned in front of a window. And to the extent a RLAN may be on a high floor overlooking a lower rooftop with a FS link, windows in new and renovated buildings are increasingly coated for environmental reasons that also mitigate any signal leakage outdoors.

Second, the record demonstrates that FS links are high power and use high-quality, highly-directional antennas. Even standard-quality FS antennas would protect outdoor fixed links from RLAN signals only two degrees off the antenna's axis, while the sort of high-performance FS antennas typical in urban or other congested areas – where an indoor Wi-Fi router or RLAN device on an upper floor would most likely occur – are far more protective.[45]

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[43] *See, e.g.*, RKF Engineering Services, *Frequency Sharing for Radio Local Area Networks in the 6 GHz Band* 24-26 (Jan. 2018) ("RKF Study"), *attached to* Letter from Paul Margie, Counsel, Apple Inc., Broadcom Corporation, Facebook, Hewlett Packard Enterprise, and Microsoft Corp. to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 17-183 (filed Jan. 26, 2018).

[44] *Id*. at 14.

[45] *See* Letter from Apple Inc., Broadcom, Inc., Cisco Systems, Inc., Facebook, Inc., Google LLC, Hewlett Packard Enterprise, Intel Corporation, Microsoft Corporation, Qualcomm Incorporated, and Ruckus Networks, an ARRIS Company to Marlene H. Dortch, Secretary, Federal Communications Commission,

Sharing between two fixed services will never be absolutely risk-free, but it's hard to imagine two operations that could coexist with a higher comfort level than high-power, outdoor FS and very low power, indoor-only RLAN devices. Wi-Fi and other unlicensed devices also operate at very low duty cycles with low EIRP, as the high-tech industry coalition study documented, with the result that even the rare cases of leakage to a close-by FS receiver would cause interference in very brief and infrequent bursts.[46]

Third, moving Wi-Fi and other unlicensed traffic onto networks required to be low power and indoors could reduce the overall risk of interference to FS incumbents. The obvious reason is that these RLAN devices will be required to be low power and indoors. If 1,200 megahertz is available at low power indoors and without an AFC requirement, much of the unlicensed traffic that might have been at higher power (and higher cost) will instead rely on low-power, indoor-only RLAN. The Commission should not want to force homes and businesses to operate at higher power and higher cost – but that would be the result if the 500 megahertz at U-NII-5, which is closest to 5 GHz unlicensed bands, and 350 megahertz at U-NII-7 are available only at higher power and higher cost, due to the AFC requirement.

The less obvious reason is that by making 1,200 contiguous megahertz of 6 GHz spectrum available inside every building, unlicensed routers and other devices will spread their transmissions over multiple and much wider channels, which substantially lowers the power spectral density (PSD) and therefore the risk of interference. With access to U-NII-5 and U-NII-7, Wi-Fi routers will have as many as *seven* 160 MHz channels – and twice that many 80 MHz channels – over which to spread transmissions.

GN Docket No. 17-183, at 9 (filed May 14, 2018).

[46] *RKF Study*, *supra*, at 17-23.

IV. The Commission Should Authorize Higher Power Limits for Outdoor Operations Under the Control of an AFC to Promote Rural Broadband

The PIOs urge the Commission to use this 6 GHz proceeding as an opportunity to provision 'spectrum as infrastructure' to facilitate more high-capacity and affordable fixed wireless broadband deployments in rural and other underserved areas. The Commission seeks comment "on whether higher power operations could be permitted in rural and underserved areas under certain conditions."[47] Unfortunately, rather than adopt rules harmonized with the Part 15 rules that allow higher gain antennas in the 5 GHz bands currently in use for rural broadband and allow for higher EIRP operations, the *NPRM* tentatively proposes to severely limit the range and hence the affordability of using U-NII-5 and U-NII-7 to deploy fixed wireless broadband. The PIOs believe there is no need to deviate from the antenna gain and power limits that apply to the 5 GHz U-NII bands since any deployments will be subject to coordination and approval by the AFC. Because equipment that has been long deployed in the 5 GHz is easily adaptable to operate in the 6 GHz band, new fixed wireless broadband networks can be quickly placed in operation, especially if the technical rules are harmonized.

Further, although rural broadband deployment would be a primary beneficiary of rule permitting higher-power operations, the Commission should not impose any such limitation that would prevent higher-power operations from being used wherever the AFC authorizes.

Nor is there a reason to preclude point-to-multipoint (P2MP) deployments, which are needed most in rural and underserved areas. The Commission's proposed AFC requirement, coupled with a professional installation requirement, should remove any concern about either

[47] *Ibid* (citation omitted).

higher antenna gain or P2MP deployments. If a higher-power operation in a particular location will cause harmful interference to an incumbent, the AFC will simply deny the request.

As both the Public Interest Spectrum Coalition and the Broadband Connects America Coalition argued at length in their respective C-band comments last fall, rural, tribal and small town America lacks access to high-speed broadband at much higher rates than their counterparts in urban and suburban areas.[48] The Commission's 2018 Broadband Deployment Report found that roughly 30% of rural Americans live in a census tract where no internet service provider offers a fixed high-speed broadband service, while only 2 percent of the urban population lacks at least one provider offering 25/3 Mbps service.[49] Independent studies, such as one from Microsoft, suggest that those numbers are much higher.[50] As of December 2016, 16 percent of rural Americans lacked access to fixed terrestrial broadband service even at 10/1 Mbps.[51] Overall, more than 24 million Americans lack access to fixed terrestrial broadband at 25/3 Mbps.[52]

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[48] Comments of the Public Interest Spectrum Coalition, GN Docket Nos. 18-122 and 17-183 (Oct. 29, 2018); Comments of the Broadband Connects America Coalition, GN Docket Nos. 18-122 and 17-183 (Oct. 29, 2018), *See also* Broadband Access Coalition Comments, GN Docket Nos. 18-122 and 17-183, at 8-11 (Oct. 29, 2018).

[49] 2018 Broadband Deployment Report, ("2018 Broadband Deployment Report"), GN Docket No. 17-199 (Feb. 2, 2018), ¶ 50, Table 1.

[50] Steve Lohr, "Digital Divide Is Wider Than We Think, Study Says," The New York Times (Dec. 4, 2018), https://www.nytimes.com/2018/12/04/technology/digital-divide-us-fcc-microsoft.html ("Over all, Microsoft concluded that 162.8 million people do not use the internet at broadband speeds, while the F.C.C. says broadband is not available to 24.7 million Americans. The discrepancy is particularly stark in rural areas. In Ferry County, for example, Microsoft estimates that only 2 percent of people use broadband service, versus the 100 percent the federal government says have access to the service.").

[51] *Id.*, 738, n.261.

[52] 2016 Broadband Progress Report, 31 FCC Rcd 699, at ¶ 50 (Jan. 28, 2016), available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-16-6A1. This data very likely understates the degree to which rural Americans lack access to high-speed broadband. *Id.*, 738, n.261 (the average land area of

This lack of access contributes to a growing gap between the vibrancy of local economies in rural areas compared to urban and suburban areas. Studies show both people and economic activity is moving out of rural areas lacking high-speed and affordable broadband. The lack of high-speed and affordable broadband access brings wide-ranging harms, both economically and socially. Without high-speed broadband access, rural Americans are left at a disadvantage in relation to the modern workplace, educational system, access to online government services and many entertainment options. Nearly a quarter (24 percent) of rural Americans surveyed by the Pew Research Center survey said that access to high-speed broadband is a "major problem" in their local community, while only 9 percent of suburban Americans and 13 percent of urban Americans said the same.[53]

Even in rural areas where high-speed broadband has been deployed, consumers are less likely to have a choice among competing providers. The Commission's 2016 Broadband Progress Report found that only 13% of Americans living in rural areas have more than one broadband provider, 48% have one provider, and 39% have none. [54] Even when rural consumers have access to broadband, they frequently pay more money for lower quality service despite the fact that, on average, they earn less than Americans living in urban areas.[55] The increased cost

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census tracts without 25/3 Mbps access is 84.8 square miles compared to 5.9 square miles for census tracts with access).

[53] Monica Anderson, "About a quarter of rural Americans say access to high-speed internet is a major problem," *Pew Research Center* (Sep. 10, 2018), http://www.pewresearch.org/fact-tank/2018/09/10/about-a-quarter-of-rural-americans-say-access-to-high-speed-internet-is-a-major-problem/.

[54] The Commission's 2016 Broadband Progress Report found that only 13 percent of Americans living in rural areas have more than one broadband provider, 48 percent have one provider, and 39 percent have none. 2016 Broadband Progress Report, ¶ 86, Table 6.

[55] Sharon Strover, "Reaching rural America with broadband internet service," *PhysOrg*, (Jan. 17, 2018), https://phys.org/news/2018-01-rural-america-broadband-internet.html#jCp.

for worse service plays a significant role in keeping rural Americans offline, as one of the primary barriers to broadband adoption across the United States broadly is cost.[56]

A major obstacle to bringing better access and more competition in the high-speed fixed broadband market is the cost of deployment, as fiber and other wireline technologies can be five-to-seven times or more costly and far slower to deploy in less densely-populated or topographically-challenging areas.[57] More mid-band unlicensed spectrum for point-to-multipoint (P2MP) fixed wireless, on the other hand, can serve as the public infrastructure that enables high-speed broadband in underserved areas at a fraction of the cost of fiber and other wireline technologies. Capital costs to deploy fixed wireless systems are a fraction – about one-seventh the cost – of fiber and are still able to provide high-throughput broadband service.[58] They are also far more cost-effective per gigabyte for this purpose than mobile systems. This comes about primarily because of their longer range through use of highly-directional client antennas (as proposed by the Coalition) that have considerable gain compared to mobile client antennas, and are mounted at a higher location above ground, typically near rooftop height. This approach also makes efficient use of spectrum, as the directional client antennas can separate out signals from multiple base stations whose coverage may overlap on the same frequency.

As in the C-band proceeding, permitting higher-power operations in the U-NII-5 and U-NII-7 bands (under AFC control) provides the opportunity to use spectrum as public

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[56] *See, e.g.* Monica Anderson, "Digital divide persists even as lower-income Americans make gains in tech adoption," The Pew Research Center (March 22, 2017), http://www.pewresearch.org/fact-tank/2017/03/22/digital-divide-persists-even-as-lower-income-americans-make-gains-in-tech-adoption/; Amina Fazlullah, "Research Shows Cost is Biggest Barrier to Broadband Adoption," Benton Blog (Jan. 11, 2016), https://www.benton.org/blog/research-shows-cost-biggest-barrier-broadband-adoption.

[57] Jennifer Levitz and Valerie Bauerlein, *Rural America is Stranded in the Dial-Up Age*, Wall St. J., June 16, 2017, at A1. The article estimates that it costs $30,000 per mile to install optical fiber.

[58] *See* The Carmel Group, *Ready for Takeoff: Broadband Wireless Access Providers Prepare to Soar with Fixed Wireless*, at 12, Fig. 6 (2017).

infrastructure to provide high-capacity broadband at affordable prices to rural, tribal and underserved areas across the country at no cost to the U.S. Treasury. Both PISC and the advocates of rural communities that comprise the Broadband Connects America Coalition have observed that "[d]eploying high-throughput fixed broadband to rural and small town America does not need to depend entirely on the Connect America Fund and other subsidy programs."[59] Fiber-based solutions cannot be built without substantial public subsidies in areas where population density is low. This makes access to unused mid-band spectrum capacity for high-throughput and affordable fixed broadband service an essential tool for bridging the rural and underserved broadband gap.

V. An Automated Frequency Coordination System for Outdoor Use Can be Streamlined, Flexible and Delegated to an Industry Multi-Stakeholder Group to Design

The PIOs strongly support the Commission's proposal that "standard-power access points be required to obtain a list of permissible [or prohibited] frequencies from an AFC system prior to transmitting."[60] We likewise concur that in this band the AFC system can be "a simple database that is easy to implement."[61] Automated frequency coordination systems are well-established and reliable, particularly with respect to the U-NII-5 and U-NII-7 band segments, where incumbent operations are geographically fixed, technically well-characterized, and change either location or operating parameters infrequently.

[59] *Id*. at 17-21. "Deploying high-throughput fixed broadband to rural and small town America does not need to depend entirely on the Connect America Fund and other subsidy programs. By authorizing coordinated and shared use by point-to-multipoint (P2MP) fixed wireless services, the Commission can unlock unused spectrum as infrastructure to improve high-speed broadband access in rural areas at no cost to the Treasury." *Ibid*.

[60] *NPRM* at ¶ 25.

[61] *Ibid.*

AFC System Operation: The PIOs suggest that the Commission adopt a flexible approach in its authorization of AFC operators. We agree that multiple and competing AFC operators should be certified, just as the Commission has done throughout its path-breaking evolution from database-assisted coordination (the 70/80/90 GHz bands), to the first fully-automated coordination system (multiple TV Bands Databases), to the world's first dynamic Spectrum Access System (governing the new Citizens Band Radio Service at 3.5 GHz). But while each of those database coordinators are based on a centralized model – and required to share and synchronize registrations and assignments granted – for 6 GHz the Commission can adopt a more result-oriented and flexible framework that allows competing approaches that may be considerably more decentralized.

The PIOs recommend that the Commission allow both centralized and decentralized models for device and end-user coordination. While it's critical that the agency require every AFC system to rely on a single, frequently-updated source of licensing data (either ULS or some other designated repository), the actual computation of protection zones and frequency availability at a specific location, as well as the periodic renewal of that grant, can quite readily be calculated by decentralized AFC operators.

For example, a manufacturer of RLAN routers or devices should be allowed to seek certification as an AFC, as should a major retailer, an association of ISPs, or an independent technology company. There are potential trade-offs, to be sure. In the case of an OEM, retailer or association of ISPs, one advantage for consumers would be the ability (and hopefully the incentive) to incorporate the cost of the AFC service into the cost of the device or connectivity service fee. Cost recovery for AFC operators should be a given; but the Commission should also strive to minimize transaction costs, or arrangements that exclude or deter ordinary consumers.

Incorporating AFC costs into the cost of a device or subscription service (e.g., Internet access) would therefore seem to be a plus for both consumers and the industry.

At the same time, we recognize that purveyors of devices and connectivity service will have an inherent incentive to maximize the utility of the band and, therefore, a potential bias against stringent protection of incumbent operations. It's therefore essential that the Commission adopt clear and results-oriented rules governing the protection criteria and licensing data that must be objective inputs into the AFC's computation engine so that the outcome is accurate and sufficiently protective of incumbent users who are themselves coordinated into this shared band. Although protection criteria and many other technical details can be (and likely should be) delegated to a multi-stakeholder process, as it was with CBRS, the Commission must maintain complete public transparency and ultimate control over the further definition and implementation of the agency's rules.

The Commission can also leverage this incentive in favor of the public interest by giving any certified AFC system the flexibility to incorporate real-world GIS data (e.g., terrain, clutter, building material) and a range of advanced propagation models that facilitate both a more intensive use of the band and a more precise protection of incumbent operations. Variation among AFC operators is positive for innovation and to encourage a diversity of use cases and service tiers. For example, while one OEM may find it sufficient to either operate or retain an AFC that gives a "red light, green light" answer to queries from low-cost devices based on a simple "exclusion zone" methodology, another AFC operator may be motivated to perform a far more granular computation that takes GIS data into account and generates, for example, results that reflect more of "protection zone" analysis that may indicate a location is available but only at a lower transmit power, or with a directional antenna.

***Device Registration*:** The PIOs' view on device registration hinges primarily on whether the Commission authorizes, as we urge in Section III above, lower-power and indoor-only unlicensed use across the U-NII-5 and U-NII-7 band segments without the added cost and complexity of AFC coordination. If unlicensed use of the 850 megahertz in those two band segments inside homes, stores and offices is subject to ongoing AFC control, that means ordinary consumers and small business owners will be swept up in a registration process and the payment of fees. Even worse would be a requirement of professional installation. Under that scenario, proposed in the *NPRM*, The PIOs strongly oppose any device registration requirement. It will deter use and invade privacy if applied to individuals purchasing what we hope will continue to be off-the-shelf and do-it-yourself gear for indoor-only home and business use.

On the other hand, if AFC control is limited to higher-power devices, whether outdoor or indoor, the justification for a registration requirement becomes stronger. Under that scenario, there actually would be both a need for a coordination process (justifying a fee), as well as a far greater need to identify the location of devices that do create harmful interference. Outdoor deployments would be professionally installed and mostly by ISPs and other firms or institutions (e.g., universities, office complexes, hotels) that could quite readily cope with both the potential cost and complexity of AFC registration and periodic reauthorizations. Under this scenario, taking advantage of the option to operate at higher power would be voluntary and almost certainly associated with enterprise routers, networked APs, and other gear managed by professionals or at least by more sophisticated individuals specifically seeking broader coverage than a typical home or office/retail space.

***ULS Licensing Data Repository*:** The PIOs agree with the Commission's proposal that AFC systems "use data from ULS to facilitate access by unlicensed devices in the bands that are

used for fixed [higher power] service."[62] The PIOs further agree that it should not be necessary to mandate band incumbents (FS and FSS operators) to provide the information necessary to protect their operations from harmful interference. We agree that "licensees have significant incentives to maintain the continued accuracy of data in ULS to ensure that they are protected from harmful interference."[63] Incentives will be aligned if, going forward, band incumbents are protected only in relation to the locations and technical parameters that they (a) actually report and (b) are in actual operation.

In addition, operators of protected fixed service stations should absolutely not be able to seek mitigation for interference from either the Commission or an AFC operator until its ULS records are updated, complete and accurate. The PIOs also recommend that the Commission require that fixed service stations to report to ULS if it is ceasing or suspending service, or reducing its frequency use, for any substantial period. A failure to do so should result in an automatic and permanent loss of interference protection by the AFC for that station.

***Extend AFC Access to Portions of U-NII-6 and U-NII-8*:** The *NPRM* proposes a blanket ban on higher-power and outdoor operations by unlicensed devices in all of the U-NII-6 and U-NII-8 band segments, but also seeks comment on whether there are any ways "to protect mobile operations" in those bands.[64] For example, as the Commission suggests, the PIOs agree that an AFC system would have the capability to define a protection contour around "fixed received sites associated with mobile operations . . .."[65] An even more straightforward way to open more contiguous bandwidth for more unlicensed use would be to identify and authorize

[62] *NPRM* at ¶ 39.

[63] *Ibid.*

[64] *NPRM* at ¶¶ 59, 74.
[65] *See Id.* at ¶ 75.

AFC-controlled use of those portions of the U-NII-8 segment that are not currently populated by BAS operations. Higher-power unlicensed use, under the control of the AFC, should be authorized for both indoor and outdoor use outside of BAS service areas. This should not even be controversial for rural areas where BAS is not operating. That additional spectrum will be most useful for addressing local needs for higher-capacity and lower-cost fixed wireless (P2MP) broadband.

VI. Conclusion

Our groups strongly support the Commission's overall goal to unlock large, contiguous blocks of unlicensed spectrum needed to ensure a robust 5G wireless ecosystem for all Americans. The Commission should authorize unlicensed use of the full 6 GHz band for low power, indoor-only use to allow consumers, small businesses and community anchor institutions to readily and affordably access the 850 megahertz in the U-NII-5 and U-NII-7 band segments essential for gigabit-fast Wi-Fi and other high-capacity unlicensed technologies. The PIOs also urge the Commission to ensure that fixed wireless broadband providers in rural and underserved areas can operate on the U-NII-5 and U-NII-7 bands at higher power levels that are harmonized with the 5 GHz U-NII technical rules.

Respectfully submitted,

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February 15, 2019